

# Extraordinary optical transmission without plasmons

Esteban Moreno<sup>1</sup>, L. Martín-Moreno<sup>2</sup>, and F. J. García-Vidal<sup>1</sup>

<sup>1</sup>Departamento de Física Teórica de la Materia Condensada,  
Universidad Autónoma de Madrid, E-28049 Madrid, Spain

<sup>2</sup>Departamento de Física de la Materia Condensada,  
Universidad de Zaragoza-CSIC, E-50009 Zaragoza, Spain

Since the first demonstration of extraordinary optical transmission (EOT) through two-dimensional arrays of subwavelength holes in optically thick metallic films [1], this phenomenon has been studied in a variety of configurations. Namely, the models include the two-dimensional case (hole arrays of various shapes), and the one-dimensional situation (slit arrays). Realistic metals, perfect conductors, and other materials have been considered. It is widely admitted that the EOT is due to the coupling of the incident radiation to surface plasmon modes propagating on the metal interfaces, thanks to the surface corrugation. As a consequence, it is commonly believed that EOT is only possible for  $p$ -polarization because plasmons only occur for this polarization.

In this contribution we show that EOT is also possible for  $s$ -polarization. A surface mode is needed to mediate this resonant transmission. Since the plasmon mode is not available for  $s$ -polarization, we add a thin dielectric film on the metallic film. In this way, the system supports an electromagnetic surface wave and thus all EOT-phenomenology found for  $p$ -polarization can be reproduced for  $s$ -polarization, i.e., without plasmons.

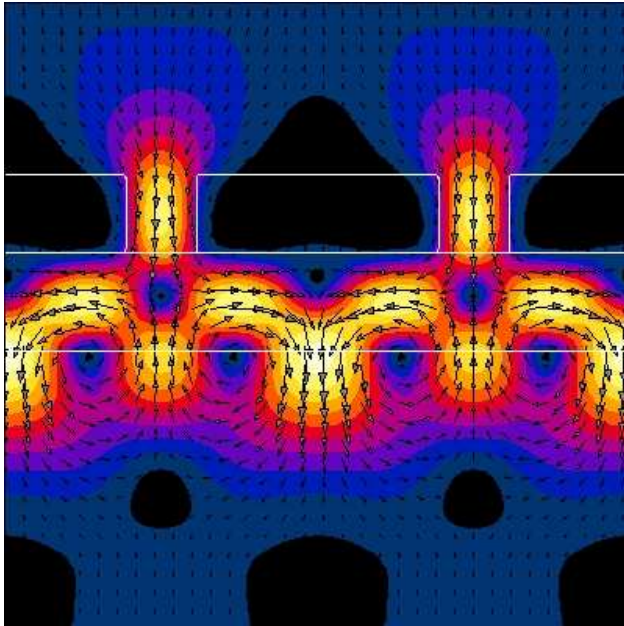


Fig. 1. Extraordinary optical transmission for the  $s$ -polarization case. A plane wave impinges (from above) on a structure made of a metallic film pierced by an array of slits, on top of a dielectric film. The plot shows the time-averaged Poynting vector field at the resonant frequency. The surface electromagnetic wave supported by the dielectric film mediates this resonant effect. In our simulations we have observed transmittances up to 100 % in perfect conductors and up to 80 % in realistic metals. Plasmons are not possible for this polarization.